Karnataka State Women's University to be an energy-surplus campus by harnessing renewable energies

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Assurance of quality energy is the most important input for development. Though India is the fifth largest producer of electricity globally, it remains a power-deficit state. It is poorly endowed with traditional fuel resources such as hydrocarbons, but blessed reasonably with renewable energy sources. Every step in harnessing them will make India energy self-sufficient. An attempt is made in this article to illustrate the initiatives of Karnataka State Women's University to reduce load on national grid.

Keywords: Bio-diesel, photovoltaic plant, renewable energies, university campus.

'*No power is costlier than No Power*'

– Homi J. Bhabha
Founder, Indian Space Research

KARNATAKA was the first state in India to have hydro-electric power station way back in 1900s. However, the state is struggling to keep pace with the ever-increasing demand for energy, but with little success. For the year 2014–15, gap between demand and supply of energy for the state was estimated to be 10,003 MW and 14.4%, while during peak the deficit was 2635 MW and 24.5% (ref. 1). A similar situation prevails in other states of India as well. At present, about 85% of our fossil fuel is imported with huge spending of foreign exchange. Such dependence makes our economy susceptible to any changes in the international price of crude oil. For instance, the Reserve Bank of India has estimated that every US$ 1 increase in crude oil price adds 15 basis points to India's wholesale price index as a direct effect, and another 15 basis points as an indirect effect[2]. It underlines the need to reduce our dependence on imports and to increase the share of renewable energies in our energy basket[3]. In this context, we need to explore and harness all options of energy (particularly renewable energy) irrespective of volume generated/harnessed.

Typically, energy requirements of any university can be divided into three types, viz. electricity, LPG and petrol/diesel. Electricity is needed primarily for lighting, heating and cooling, with peak demand coming during working hours; LPG for heating and petrol/diesel for transportation needs. A typical university with about 1500 students in various postgraduate (PG) programmes with associated colleges would have a monthly demand of about 125,000 to 175,000 units, which contributes significantly to the university expenses. Similar is the position for Karnataka State Women's University (KSWU) with regard to energy requirement. Established in 2003 in Vijayapur (Bijapur), the University is still in its developing stages with every passing year having a new department/programme being added, thus increasing its energy requirement. KSWU is the only university in Karnataka dedicated exclusively for women's education. It is recognized under 2(f) and 12(B) of the UGC Act. KSWU offers various UG programmes in Arts, Business Administration, Computer Applications, Commerce, Education, Fashion Technology, Home Science, Physical Education, Science and Social Work. It also offers about 20 PG courses, PG diploma and certificate courses in the faculties of Arts, Commerce and Management, Social Sciences, Science and Technology, and Education. The University is dedicated to promote excellence through academic achievement, research, creativity, innovation, interaction and collaboration, personality development and leadership qualities.

Located in the semi-arid region of the northern Deccan Plateau, with agriculture as the primary economic activity, under the jurisdiction of Hubli ESCOM, inadequate power supply is common, more so during summer period. To overcome the power shortage problem and also to make better use of native oilseed plants such as neem, KSWU has drawn a plan to harness the renewable energy sources for its own consumption. Following are the renewable sources adopted, viz. photovoltaic technology for electricity generation and lighting in common areas by installing solar lights; methane from kitchen waste, and bio-diesel from oilseeds.

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Table 1. Average monthly solar irradiation

Variable/month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Insolation (kWh/m^2/day)	4.95	5.78	6.42	6.70	6.52	5.03	4.42	4.36	4.80	5.01	4.93	4.69
Clearness (0 to 1)	0.63	0.66	0.65	0.64	0.61	0.47	0.41	0.41	0.48	0.55	0.61	0.62
Temperature (°C)	23.63	26.59	30.62	31.43	32.12	27.91	26.40	26.05	26.68	26.20	24.63	22.96
Wind speed (m/s)	2.13	2.44	2.44	2.88	4.02	5.29	4.99	4.60	3.28	2.52	2.40	2.17
Precipitation (mm)	3	6	8	20	38	117	158	155	203	89	21	6
Wet days	0.4	0.4	0.6	1.8	2.4	7.1	9.2	8.4	9.3	4.4	1.4	0.4

Source: NASA Langley Research Center Atmospheric Science Data Center; http://www.gaisma.com/en/location/gulbarga.html (accessed on 9 December 2014).

Table 2. Solar photovoltaic plant details

Technical details	
Total installed capacity	3.45 × 3 nos = 10.35 kW
Specification of module	High concentration PV system (HCPV) employs concentrating optics consisting of lenses that concentrate sunlight; they are favoured over silicon as they are more efficient
Make of modules	Suntrix, Australia
No. of modules in each unit	12
Module efficiency	28–30%.
Series parallel combination	Three series, four parallel
Tilt angle of modules	Mounted on dual-axis sun-tracking system
Input voltage of inverter	120 V DC
Output voltage of inverter	230 V AC
Total no. of tube lights connected to each unit	25 (40 W each).
Total no. of fans connected to each unit	25 (60 W each).
Energy generation details	
Generation/day/plant (according to metering details)	10 to 11 units
Total generation of three plants	30–33 units
Demand	42–46 units/day
Cost of power purchase	Rs 5.40/unit
Energy savings	Average 30–33 units/day
Energy savings per annum	12,045 units
Cost saving per annum	Rs 65,043
Capital cost of installation	Rs 48.95 lakhs

Figure 1. Rooftop solar photovoltaic unit.

PV technology

The KSWU campus is located in a region of surplus solar irradiation (Table 1), with an approximate solar irradiation value of 4 kWh/m^2/day. About 350 days are expected to have sunshine. With such irradiation values, solar PV technology can be adopted for generation of electricity. However, the power generation cycle through PV starts at 11.00 h and drops after 16.00 h, thus making it the most suitable option for use in student hostels as energy demand in the hostels during day time is least[4].

To begin with KSWU opted for three PV plants, each having a capacity of 3.45 kW, for installation as rooftop systems in three different hostels (Figure 1). Total installed capacity was 10.35 kW. All rooms in the hostels with tube lights (25 in each hostel) and ceiling fans (25 in each hostel) were connected with the PV system. Since its operation from 2013, hostels rarely experienced the power shortage, probably an exception in the region. Technical and energy saving details of the solar PV plants are given in Table 2.

As can be seen from Table 2, on an average, electricity generation per day from the hostels is about 33 units and is sufficient to cater to the demand of the hostels. About 12,000 units is generated per year from the PV plants, which resulted in savings of Rs 65,000 in the present electricity charges. Cost per unit is bound to increase regularly and hence the savings from the university are bound to increase in value in the coming years, thus reducing the buy-back period.

Lighting in common areas

Lighting in the common areas also demands energy. In the KSWU campus, wherever required, solar street lights (SSL) are used. In all, about 150 SSL were installed, each fitted with 11 W compact fluorescent lamp (CFL). Together, these lights have generated about 5840 units in 2014. Details of SSL are given in Table 3.

Methane from kitchen waste

More than 60% of the University students stay in hostels on the campus. There are four hostels at present and more are under construction. Generation of kitchen waste to the tune of 30–40 kg/day is common. Earlier, this waste was taken away to serve as cattle feed. KSWU decided to convert the kitchen waste for generation of methane by fermentation which can be used in the hostel kitchen. Accordingly, anaerobic reactor with a capacity of 4 m^3 was established and all the decomposable waste generated is used as feed stock. Methane gas generated is used in the hostels and thus helps in reduced use of LPG, equivalent of about 25 kg/month (Figure 2).

Table 3. Details of solar street lights in KSWU campus

Technical details	
Total number of solar street lights installed	150
Specification	For each unit of Solar Street Light
Module efficiency	18%
Luminary	1 × 11 W CFL
PV module	74 W
Battery capacity	12 V/75 AH
Cost for each light	Rs 21,800
Energy generation details	
Total installed capacity	74 W × 150 nos = 11.10 kW
Average power generation	15 to 16 units (assumed time period: 8 h)
Cost of power purchase	5.40 Rs/Unit
Energy savings	Average 15 to 16 units/day
Energy savings per annum	5840 units
Cost savings per annum	Rs 31,536

Figure 2. Methane from kitchen waste.

Bio-diesel from oilseeds

KSWU with the help of Karnataka State Biofuel Development Board (KSBDB) has established a Biofuel Information and Demonstration Centre in the campus. A plant with a capacity to generate 100 l/month has been established (Figure 3). This facility is suitable for neem, *Pongamia* and semarouba seeds, which are available in the region. *Pongamia* yield starts from the fifth year onwards, with each tree producing about 15–40 kg of seeds with 30–35% oil content; harvest period is from March to May. Thus, 4 kg of seeds would give about 3 litres of seed oil and 1 kg of seed cake. Each litre of seed oil upon esterification gives about 900 ml diesel and 100 ml of glycerine. Simarouba (*Simarouba glauca*) yield starts from the fifth year onwards, with each tree producing about 10–25 kg of seeds with 40–50% of oil cake; harvest period is from February to April. Thus 3 kg of seeds produces about 2.5 litres of seed oil and 500 g of seed cake. Each litre of this seed oil produces 900 ml diesel and

Figure 3. Seed oil extraction unit.

100 ml glycerine. Neem (*Azadirachta indica*) yield starts from the fifth year onwards, with each tree yielding about 10–25 kg of seeds and about 28–35% oil content. Both neem oil and neem oil cake are sought after as biopesticides for horticulture crops and therefore, neem seeds are not used for biofuel manufacturing.

To ensure constant supply of oilseeds, plantation activity was taken up in the University campus. Neem is the most preferred species for plantation in this agro-climatic zone (native and most common plant in this region). In addition to sourcing the seeds from campus, supply chain was established to procure oilseeds from villages around the campus to run the unit at optimum level.

An agreement has been made with the Karnataka State Forest Department to uplift 50% of bio-diesel produced by the Biofuel Centre. The remaining fuel will be used for the vehicle fleet of the University. From its establishment in 2011 till date, the Biofuel Centre has been working well and the University is now considering doubling the installed capacity of the centre. Further, increasing the crushing capacity would enable the university to tap the increasing yield of oilseeds from plantations within the campus, and also to bring more vehicles of the University under the biodiesel programme.

Way forward

In view of encouraging results from renewable energy and also the availability of land, KSWU is exploring options for bigger solar PV plants in its campus (grid-connected). This measure would not only help the University become energy-surplus, but also contribute to the grid thus reducing the pressure on the national grid.

1. Central Electricity Authority, Load Generation Balance Report 2014–15, Ministry of Power, Government of India, 2014.
2. ADB, Asian Development Outlook: Economic trends and prospects in developing Asia, Routes for Asia's Trades, Asian Development Bank, 2006.
3. *TERI Energy Data Directory & Yearbook*, 2011–12.
4. Chandel, M., Agrawal, G. D. and Mathur, A., Techno-economic analysis of solar parabolic trough type energy system for garment zone of Jaipur city. *Renew. Sustain. Energy Rev.*, 2013, **17**, 104–109.

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